LOWER WILLAMETTE GROUP

PORTLAND HARBOR RI/FS

FINAL REMEDIAL INVESTIGATION REPORT

APPENDIX G
BASELINE ECOLOGICAL RISK ASSESSMENT

ATTACHMENT 8
EVALUATION OF MODELS USED TO PREDICT TISSUE CONCENTRATIONS

FINAL

December 16, 2013

Prepared for
The Lower Willamette Group and
United States Environmental Protection Agency

Prepared by
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1.0 MODEL DEVELOPMENT FOR THE BERA

In the baseline ecological risk assessment (BERA), the relationships between chemical concentrations in different media were used to predict tissue concentrations. The relationship between surface sediment concentrations and biota tissue concentrations were used to predict tissue concentrations based on site-specific biota-sediment accumulation regressions (BSARs) or based on the mechanistic bioaccumulation model.

The mechanistic model and BSARs were used in the BERA to predict benthic invertebrate and sculpin tissue concentrations from sediment concentrations for COPCs for which a relationship between co-located sediment and tissue concentrations could be established based on data collected for the BERA. The predictive models used in the BERA were selected to provide methodological consistency between BERA tissue-residue predictions and risk-based preliminary remediation goals (PRGs) for the FS. Predicted tissue concentrations were compared to tissue risk thresholds. This evaluation was conducted as an additional line of evidence (LOE) for evaluating risks to benthic invertebrates and sculpin, per EPA (2008) and is presented in Section 6.0 and 7.0 of the BERA. Predicted benthic invertebrate prey tissue concentrations were also used in the evaluation of risks to spotted sandpiper and are presented in Section 8.0 of the BERA.

Details on the development of site-specific BSARs and the mechanistic model are presented in the draft bioaccumulation modeling report for the Portland Harbor RI/FS (Windward 2009). Section 2.0 of this attachment presents a brief summary of how selected BSARs and the mechanistic model were applied in the BERA. Section 3.0 presents the references.

2.0 APPLICATION OF MECHANISTIC MODEL AND BIOTA-SEDIMENT ACCUMULATION REGRESSIONS

BSARs and the mechanistic model were used in the BERA to predict benthic invertebrate and sculpin tissue concentrations from sediment concentrations. Per EPA's Problem Formulation (Attachment 2), the mechanistic model and BSARs were used to predict tissue concentrations from sediment concentration data at sediment sampling locations where tissue residue data were not collected. The predictive models used in the BERA were selected to provide methodological consistency between BERA tissue-residue predictions and risk-based preliminary remediation goals (PRGs) for the FS. The models are presented in the draft bioaccumulation modeling report for the Portland Harbor RI/FS (Windward 2009).

The mechanistic model was available for predicting total PCB, PCB TEQ, pesticide, and dioxin and furan TEQ concentrations. The mechanistic model is appropriate for modeling hydrophobic organic chemicals, so it was not used for modeling other COPCs. For these other chemicals, the development of site specific BSARs was attempted. Site-specific BSARs were selected for benthic invertebrate and sculpin tissue COPCs that met appropriate regression analysis assumptions, had a statistically significant positive slope ($p \leq 0.05$), and had an $r^2 \geq 0.30$. Windward (2009) presents the details of the BSAR analysis and the mechanistic bioaccumulation model.

Table 1 presents the COPCs for benthic invertebrates, sculpin, and spotted sandpiper and the models that were used to predict tissue concentrations.

Table 1. Models Selected to Predict Tissue Concentrations in COPC-Receptor Pairs

COPC	Benthic Invertebrates[a]	Sculpin	Spotted Sandpiper[b]
Metals			
Arsenic	None[c]	NA	NA
Cadmium	None[c]	NA	NA
Copper	None[c]	None[c]	None[c]
Lead	NA	NA	BSAR
Zinc	None[c]	NA	NA
Butyltins			
Tributyltin ion	BSAR[d]	NA	NA
PAHs			
Benzo(a)pyrene	NA	NA	BSAR[e]
Phthalates			
BEHP	NA	None[c]	
Dibutyl phthalate	None[f]	NA	None[f]

Table 1. Models Selected to Predict Tissue Concentrations in COPC-Receptor Pairs

COPC	Benthic Invertebrates[a]	Sculpin	Spotted Sandpiper[b]
PCBs			
Total PCBs	Mechanistic model	Mechanistic model	Mechanistic model
PCB TEQ	NA	NA	Mechanistic model
Dioxins/Furans			
Total dioxin/furan TEQ	NA	NA	Mechanistic model
Total TEQ	NA	NA	Mechanistic model
Pesticides			
Aldrin	NA	NA	Mechanistic model
beta-HCH	NA	Mechanistic model	NA
Sum DDE	NA	NA	Mechanistic model
Total DDx	Mechanistic model	Mechanistic model	Mechanistic model

[a] Benthic invertebrate COPCs were identified for each of the following receptors: clams, crayfish, lab clam, and lab worms.

[b] Predicted COPC concentrations were developed for spotted sandpiper prey (i.e., clams and laboratory-exposed worms).

[c] Site-specific BSARs were not selected for these COPCs because these COPCs is not meet the appropriate BSAR analysis assumptions (Windward 2009), did not have a statistically significant positive slope ($p < 0.05$), and/or had an $r^2 < 0.30$.

[d] TBT BSARs were developed only for laboratory-exposed worms and laboratory-exposed clams; however, only the TBT BSAR for laboratory-exposed worms was used to predict tissue concentrations because the TBT BSAR for laboratory-exposed clams failed at predicting empirical field clam tissue TBT data.

[e] A dibutyl phthalate BSARs was developed only for field clams. None was developed for laboratory-exposed worms because data for this COPC-receptor pair did not meet the appropriate BSAR analysis assumptions (Windward 2009), did not have a statistically significant positive slope ($p < 0.05$), or had an $r^2 < 0.30$.

[f] No appropriate BSAR model could be developed because too few sediment and tissue detected concentration data pairs were available (n=5) to develop a model.

BEHP – bis(2-ethylhexyl) phthalate
BSAR – biota-sediment regression
COPC – contaminant of potential concern
DDD – dichlorodiphenyldichloroethane
DDE – dichlorodiphenyldichloroethylene
DDT – dichlorodiphenyltrichloroethane
HCH – hexachlorocyclohexane
NA – not applicable; not a COPC-receptor pair
PAH – polycyclic aromatic hydrocarbon
PCB – polychlorinated biphenyl
TBT – tributyltin
TEQ – toxic equivalent
total DDx – sum of all six DDT isomers (2,4′-DDD; 4,4′-DDD; 2,4′-DDE; 4,4′-DDE; 2,4′-DDT; and 4,4′-DDT)

A TBT BSAR was developed for laboratory-exposed clams; however, this BSAR was not used to predict tissue concentrations because it fails at predicting the empirical field clam tissue TBT data. As shown in Figure 1, the BSAR for laboratory-exposed clams in almost all cases overpredicts the empirical tissue concentration. A BSAR that is unable to predict empirical, field-collected data was judged to be an inappropriate model for predicting tissue concentrations elsewhere. Therefore, only the laboratory-exposed worm TBT BSAR was used to predict tissue concentrations and was the only information available for estimating TBT bioaccumulation in benthic infaunal consumers.

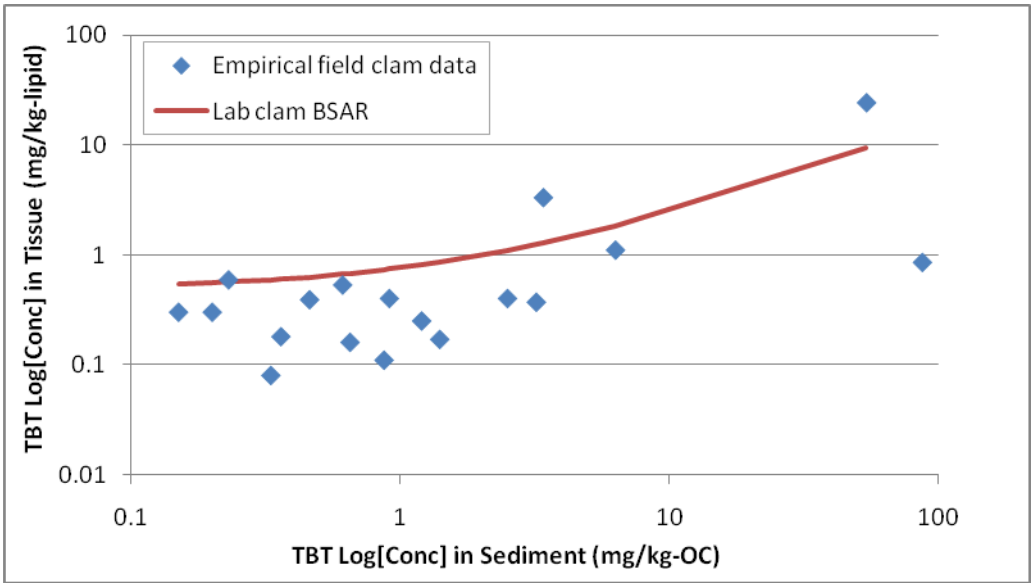

Figure 1. Laboratory-Exposed TBT BSAR and Empirical Field-Collected Clam TBT Concentrations

3.0 REFERENCES

EPA. 2008. Problem formulation for the Baseline Ecological Risk Assessment at the Portland Harbor Site. Report and letter dated February 15, 2008 to Lower Willamette Group (from E. Blischke and C. Humphrey to J. McKenna and R. Wyatt). US Environmental Protection Agency Region 10, Oregon Operations Office, Portland, OR.

Windward. 2009. Portland Harbor RI/FS bioaccumulation modeling report. Draft. WW09-0003. Prepared for Lower Willamette Group. July 21, 2009. Windward Environmental LLC, Seattle, WA.